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(54) **KVMP SWITCH ALLOWING ASYNCHRONOUS AND SYNCHRONOUS SWITCHING FOR CONSOLE DEVICES AND PERIPHERAL DEVICES AMONG DIFFERENT COMPUTERS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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G06F 13/12 (2006.01)

(52) **U.S. Cl.** **710/72**; 710/10; 710/16

(58) **Field of Classification Search** 710/306–317, 710/62–64, 72–73, 8–19; 709/227–232
See application file for complete search history.

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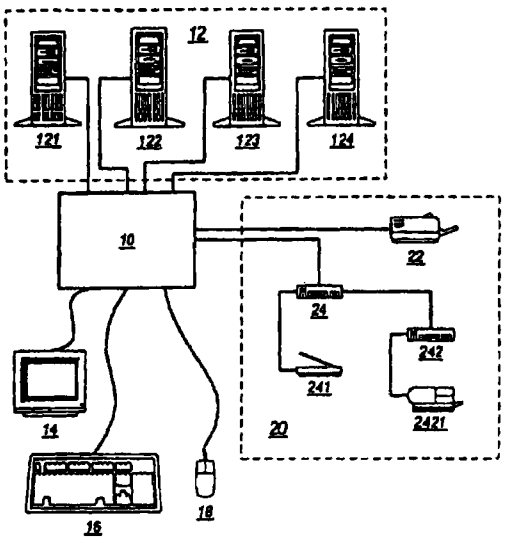
(57) **ABSTRACT**

A signal switch for sharing a video monitor, a plurality of console devices compliant with an industry standard and one or more than one peripheral device in any of a plurality of computer systems, is provided. A KVM switch allows all the computers connected to the switch to share any USB peripheral devices, and which can switch the KVM channels and peripheral channels to a common computer or to different computers either asynchronously or synchronously without interruption of data flow to that peripheral when the switch is changed. In another embodiment the KVM switch allows a keyboard and a mouse of a user console to separately control two different computers. In another embodiment, the KVM switch is connected to the computers via computer connection modules and connected to a user console and peripheral devices via a console connection module.

23 Claims, 7 Drawing Sheets



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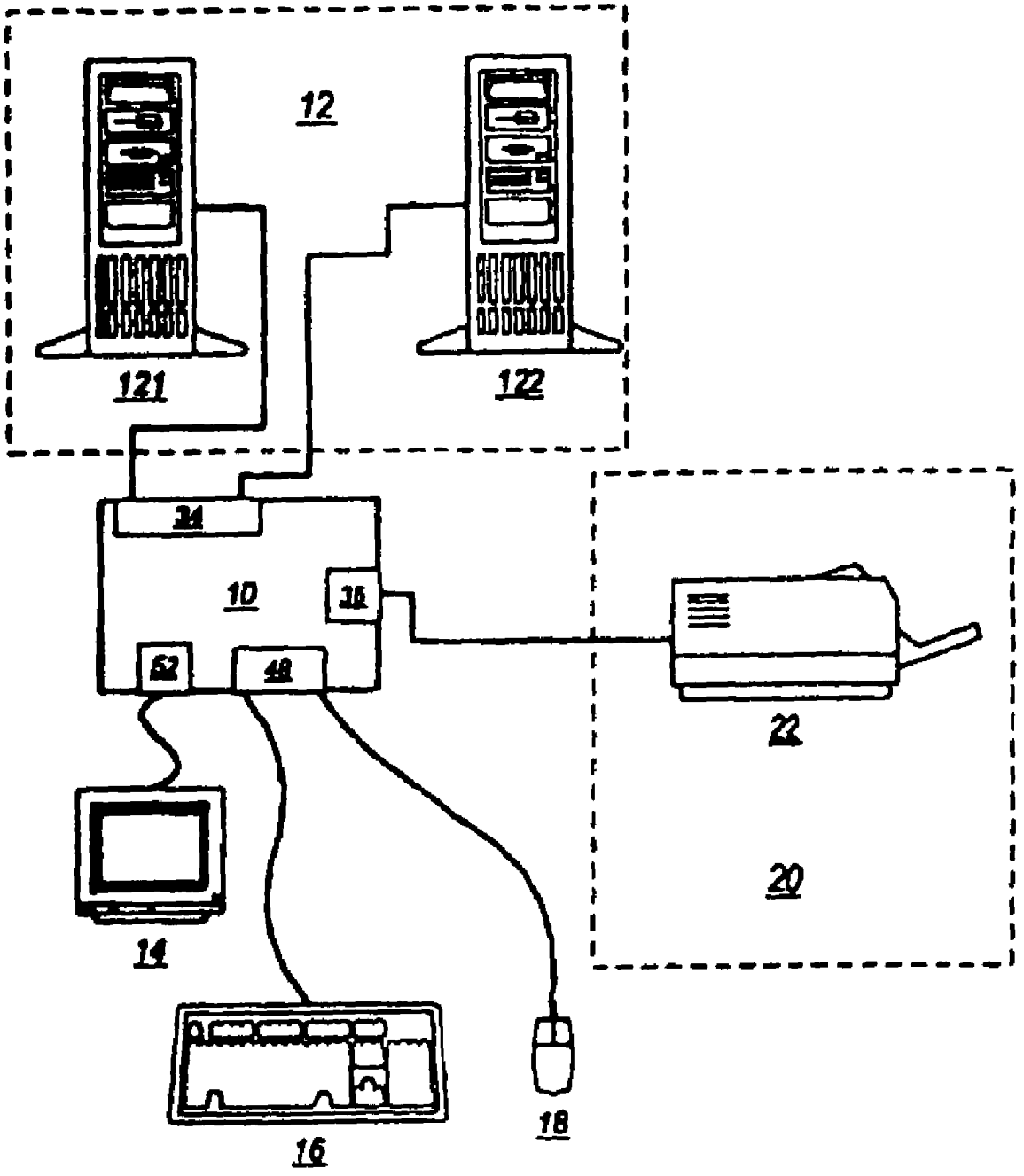

Fig. 1

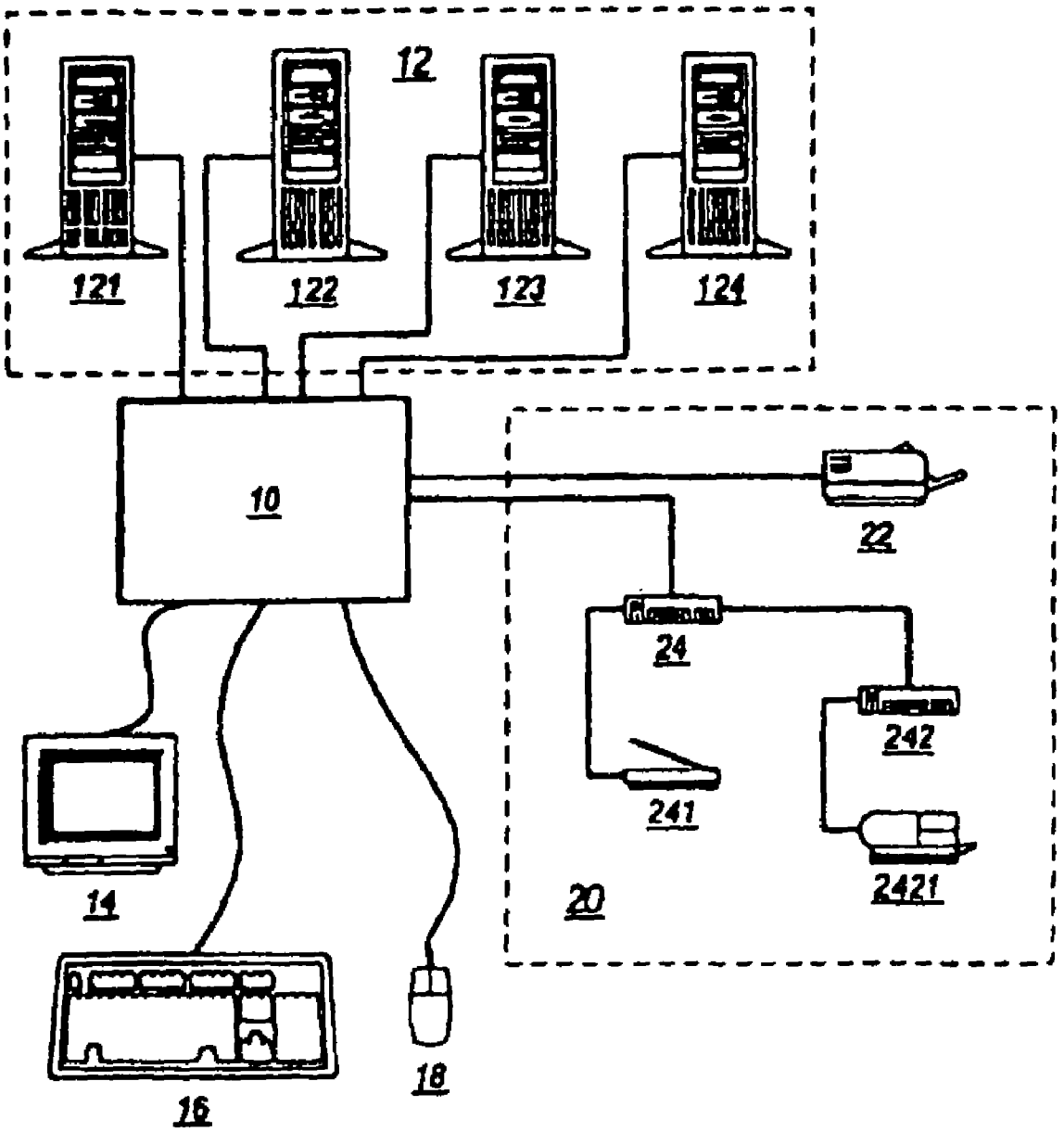

Fig. 2

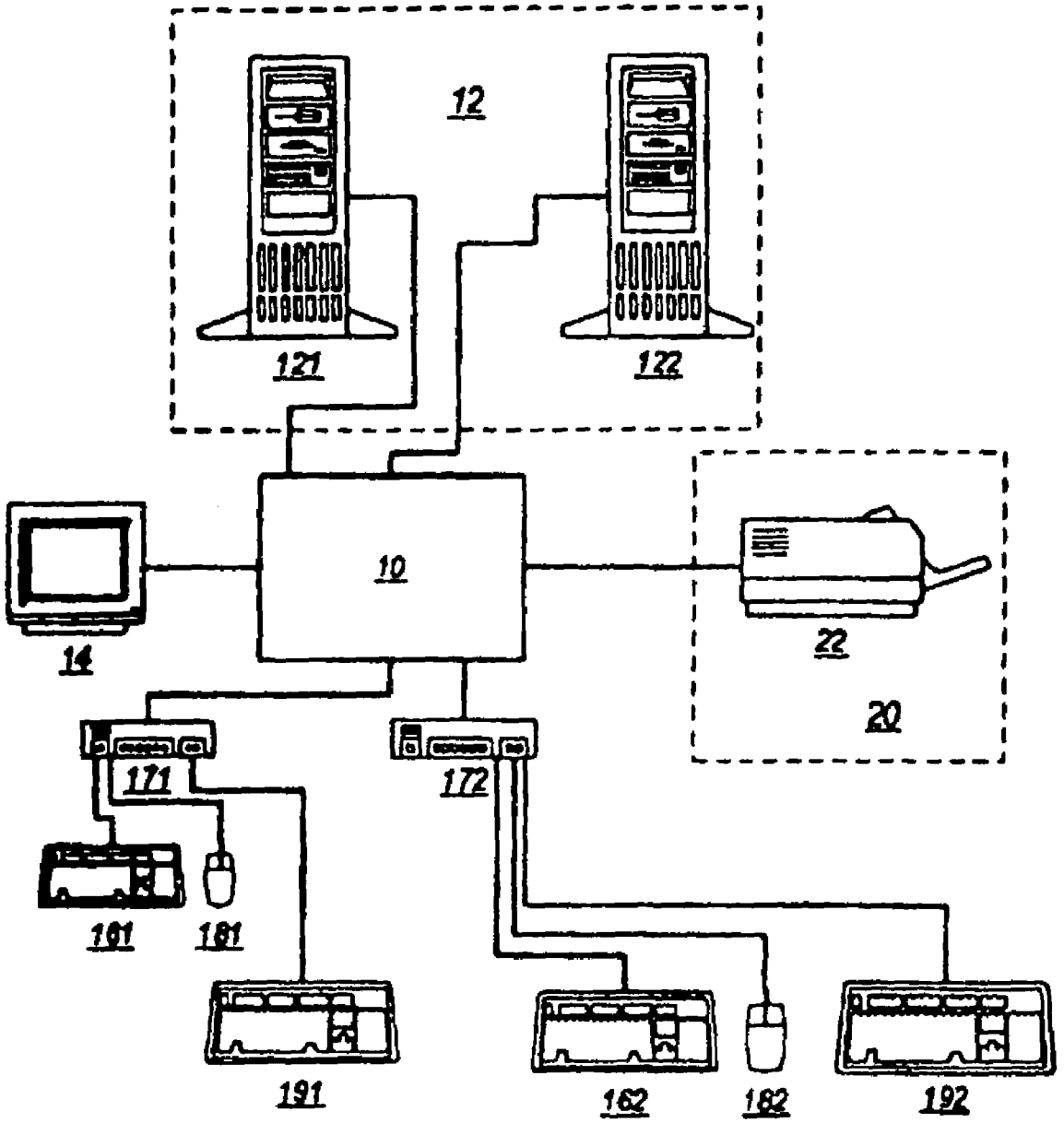

Fig. 3

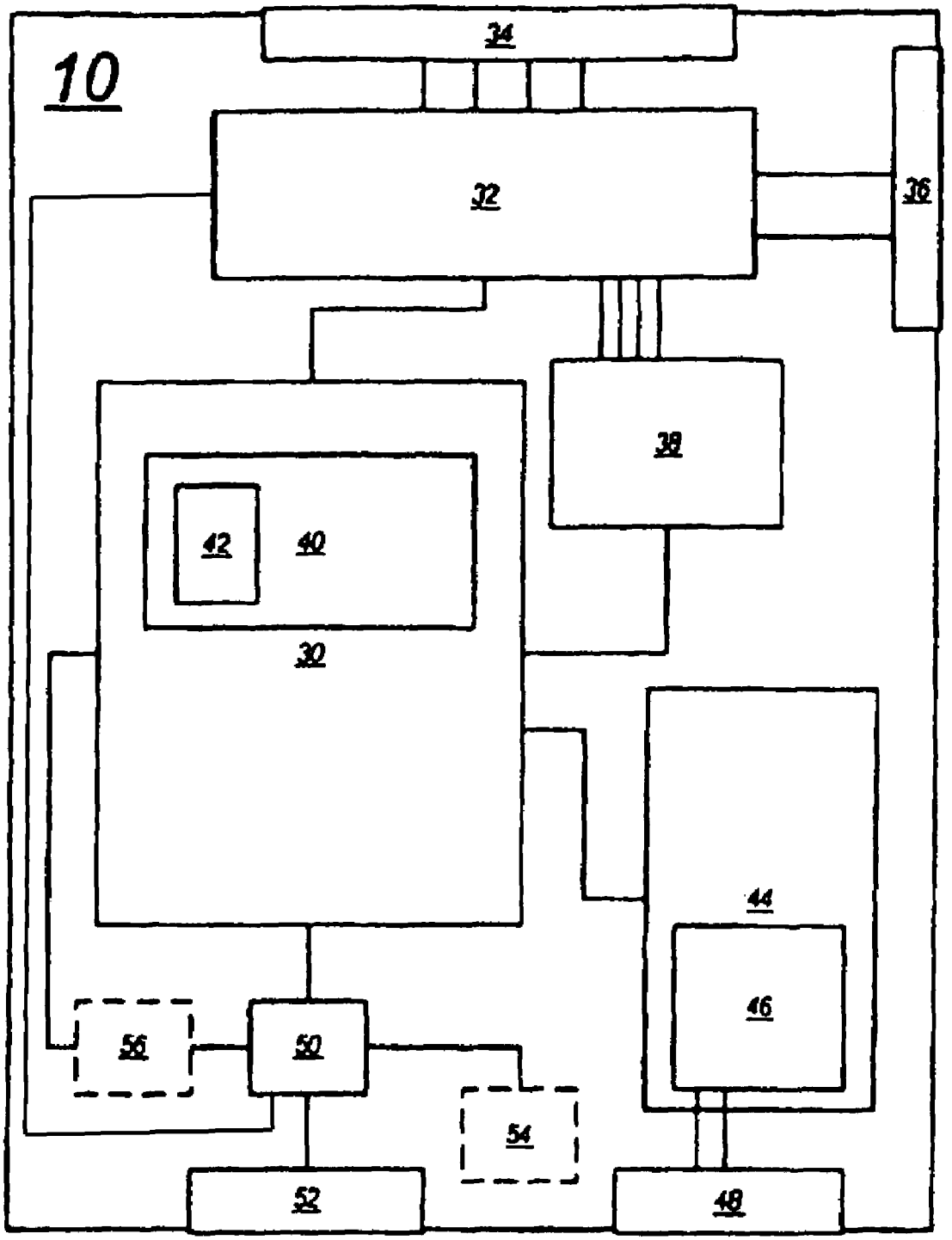

Fig. 4

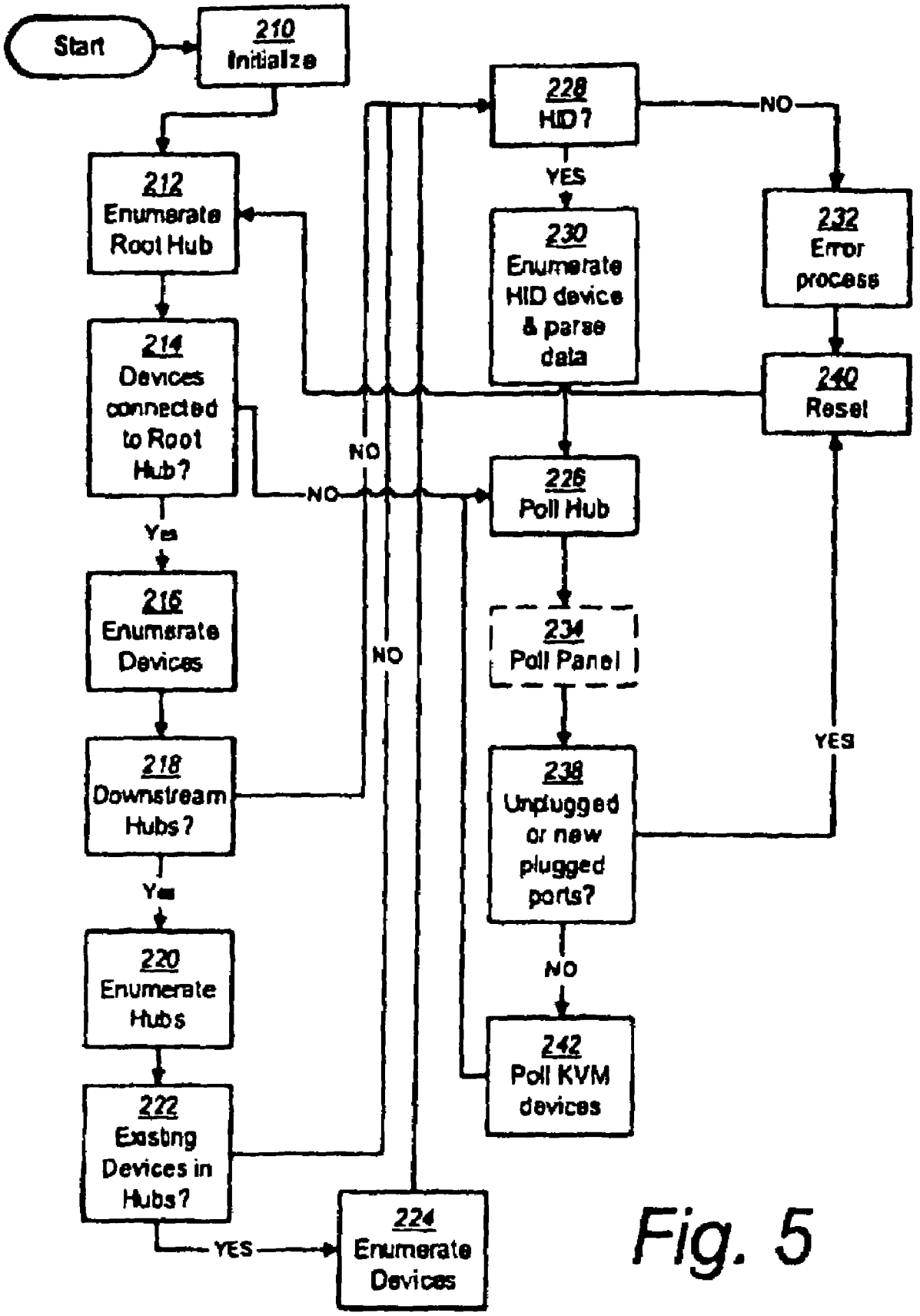
Start
210 Initialize
212 Enumerate Root Hub
214 Devices connected to Root Hub?
NO
Yes
216 Enumerate Devices
218 Downstream Hubs?
NO
Yes
220 Enumerate Hubs
222 Existing Devices in Hubs?
NO
YES
224 Enumerate Devices
228 HID?
NO
YES
230 Enumerate HID device & parse data
226 Poll Hub
234 Poll Panel
238 Unplugged or new plugged ports?
NO
YES
242 Poll KVM devices
232 Error process
240 Reset

Fig. 5

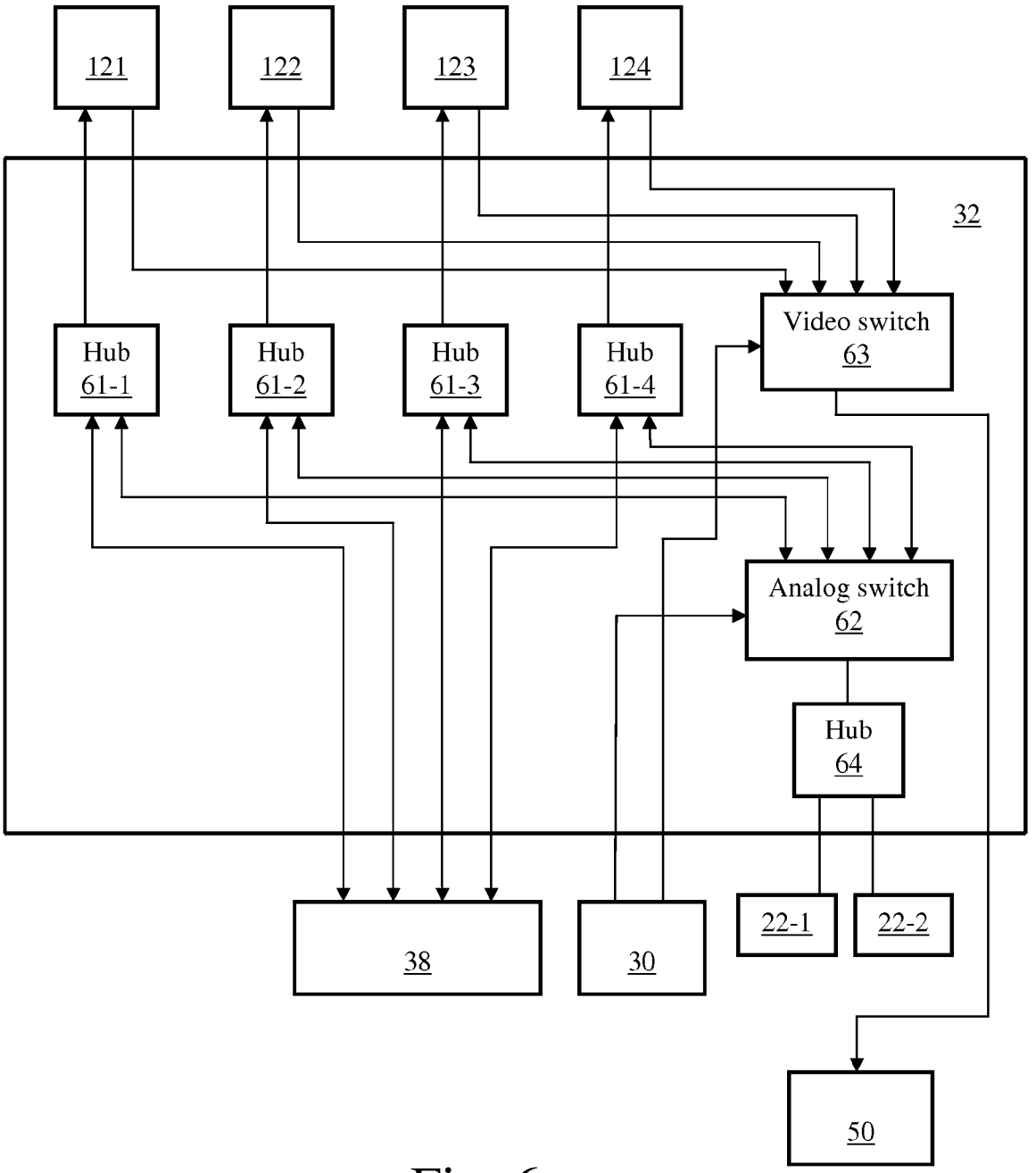
121
122
123
124
32
Video switch
63
Hub
61-1
Hub
61-2
Hub
61-3
Hub
61-4
Analog switch
62
Hub
64
22-1
22-2
38
30
50

Fig. 6

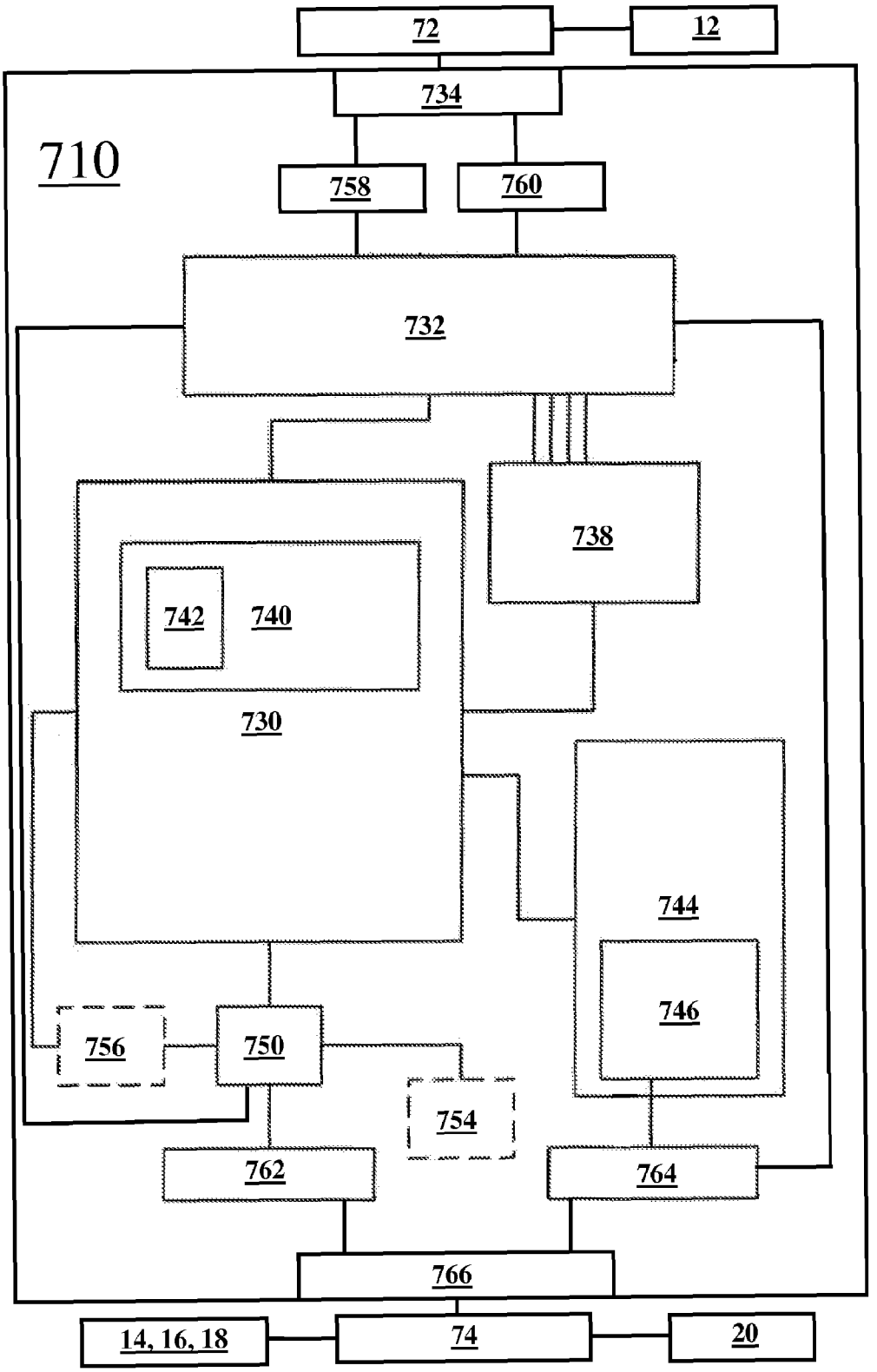
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Fig. 7

KVMP SWITCH ALLOWING ASYNCHRONOUS AND SYNCHRONOUS SWITCHING FOR CONSOLE DEVICES AND PERIPHERAL DEVICES AMONG DIFFERENT COMPUTERS

This application is a continuation-in-part of U.S. application Ser. No. 11/727,333, filed Mar. 26, 2007, now allowed, which is herein incorporated by reference in its entirety. U.S. application Ser. No. 11/727,333 is a continuation of U.S. application Ser. No. 11/204,036, filed Aug. 16, 2005, now U.S. Pat. No. 7,340,556, which is in turn a continuation of U.S. application Ser. No. 10/065,375, filed Oct. 10, 2002, now U.S. Pat. No. 6,957,287, which claims priority from U.S. Provisional Application No. 60/338,071, filed Nov. 9, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a signal switch for sharing one or more than one video monitor, keyboard, mouse and peripheral device.

2. Description of the Related Art

A single-user or multi-user keyboard-video-mouse ("KVM") switch system is a signal switch that allows a single user or multiple users to share just a single keyboard, video device and mouse, or multiple sets of keyboards, video devices and mice.

A problem with current KVM switches is that if a USB peripheral, such as a printer, is connected to the switch, data flow is interrupted to that peripheral when the switch is changed.

Universal Serial Bus (USB) is a communications architecture that gives a personal computer (PC) the ability to interconnect a variety of devices using a simple cable. The USB is actually a two-wire serial communication link that runs at either 1.5 or 12 megabits per second (Mbps). USB protocols can configure devices at startup or when they are plugged in at run time. These devices are broken into various device classes. Each device class defines the common behavior and protocols for devices that serve similar functions.

The most current information concerning the USB standard is maintained at the following site on the World Wide Web: http://www.usb.org. Available at that source are the Universal Serial Bus (USB) Specification, the USB HID Usage Supplement, and the Device Class Definition for Human Interface Devices (HID). The HID class consists primarily of devices that are used by humans to control the operation of computer systems. Typical examples of HID class devices include: keyboards and pointing devices—for example, standard mouse devices, trackballs, and joysticks; front-panel controls—for example: knobs, switches, buttons, and sliders; controls that might be found on devices such as telephones, VCR remote controls, games or simulation devices—for example: data gloves, throttles, steering wheels, and rudder pedals; and devices that may not require human interaction but provide data in a similar format to HID class devices—for example, bar-code readers, thermometers, or voltmeters.

What is needed is a KVM switch that is also a peripheral sharing switch, which would allow all the computers connected to the switch to share any USB peripheral devices without interruption of data flow to that peripheral when the switch is changed, and which would switch the KVM channels and peripheral channels to a common computer or to different computers either asynchronously or synchronously.

SUMMARY OF THE INVENTION

Embodiments of the present invention meet this need by providing a KVM switch that is also a peripheral sharing switch, which allows all the computers connected to the switch to share any USB peripheral devices, and which can switch the KVM channels and peripheral channels to a common computer or to different computers either asynchronously or synchronously without interruption of data flow to that peripheral when the switch is changed. USB peripherals may be synchronously or asynchronously switched with the KVM channels.

An embodiment of the present invention, a USB KVMP, allows multiple USB keyboards and multiple USB mice communicating with a common computer at the same time. The USB KVMP provides multiple USB peripheral channels to users and those channels can be connected with all kinds of USB peripherals, such as a USB hub, USB printer, USB scanner, USB camera, etc.

Another embodiment of the present invention provides KVM switch which allows a keyboard and a mouse of a user console to separately control two different computers.

Yet another embodiment of the present invention provides a KVM switch system in which the KVM switch is connected to the computers via computer connection modules and connected to a user console and peripheral devices via a console connection module.

In one aspect, the present invention provides a keyboard-video-mouse (KVM) switch, comprising: a first computer port for connecting to a first computer; a second computer port for connecting to a second computer; a peripheral port for connecting to at least one peripheral device; a console port for connecting to a plurality of user console devices; a first communication link connecting the first computer port and the console port; a second communication link connecting the first computer port and the peripheral port; a third communication link connecting the second computer port and the console port; and a switching unit connected to the first computer port, the second computer port, the peripheral port and the console port for switching between the first and third communication links without interrupting the second communication link.

In another aspect, the present invention provides a keyboard-video-mouse (KVM) switch system, comprising: a first computer connection module for connecting to a first computer; a second computer connection module for connecting to a second computer; a console connection module, the console connection module including at least one console connector for connecting to at least one user console device and at least one peripheral connector for connecting to at least one peripheral device; a first communication link connecting the first computer connection module and the console connector of the console connection module; a second communication link connecting the first computer connection module and the peripheral connector of the console connection module; a third communication link connecting the second computer connection module and the console connector of the console connection module; and a switching module connected to the first computer connection module, the second computer connection module and the console connection module for switching between the first and third communication links without interrupting the second communication link.

In yet another aspect, the present invention provides a signal switch for sharing a set of console devices and one or more peripheral devices among any of a plurality of computer systems, comprising: a first channel for connecting the set of console devices comprising a first console device and a second console device to a first computer system selected from the plurality of computer systems; a second channel for connecting the first selected computer system to a peripheral device selected from the one or more peripheral devices; a third channel for connecting the first console device to the first selected computer system; a fourth channel for connecting the second console device to a second selected computer system; and a switching module for switching the set of console devices from the first channel to the third channel and the fourth channel without changing the second channel between the first selected computer system and the selected peripheral device.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, aspects, and advantages of the present invention will become better understood with reference to the following description, appended claims, and accompanying drawings, where:

FIG. **1** is a system diagram of a system including a signal switch, computers, peripherals and a user console.

FIG. **2** is a system diagram of another system including a signal switch, computers, peripherals and a user console.

FIG. **3** is a system diagram of another system including a signal switch, computers, peripherals and user consoles.

FIG. **4** is a block diagram of a signal switch according to one embodiment of the present invention.

FIG. **5** is a function block diagram of process useable as a management control program for the signal switch of FIG. **4**.

FIG. **6** is a block diagram illustrating the USB hub switch module of FIG. **4**.

FIG. **7** is a block diagram of a signal switch according to another embodiment of the present invention, also showing a computer connection module and a console connection module connected to the signal switch.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is directed to a signal switch for sharing one or more than one video monitor, keyboard, mouse and peripheral device. In one embodiment, the signal switch is the combination of a KVM (keyboard video mouse) switch and a peripheral sharing switch. KVM switches are well known in the art with reference to this disclosure. The signal switch according to embodiments of the present invention allows all computers connected to the switch to share all USB peripheral devices connected to the switch.

The signal switch can either asynchronously or synchronously switch KVM channels and peripheral channels to a common computer or different computer. In other words, the KVM channels and peripheral channels may be switched together (synchronously) or separately (asynchronously).

Embodiments of the present invention utilizes USB emulation programs to emulate the HID (Human Interface Devices) specification, thereby enabling a switch to communicate with the USB ports of PCs, and through USB host emulation programs, enable a switch to communicate with USB devices such as USB keyboards and USB mice, and a USB hub. In other words, the use of emulation makes a switch appear as a computer to peripheral devices, and enables the switch to communicate with USB devices or USB PCs at the same time.

Although an embodiment is described with reference to the current HID specification, it will be apparent to those skilled in the art with reference to this disclosure that the invention may be implemented with any specification for device interfacing.

FIG. **1** illustrates one of the many ways in which the present invention may be used. In a simple configuration, a signal switch **10** according to the present invention permits a user to control a plurality of computer systems **12** (represented by first computer **121** and second computer **122**), and USB compatible peripherals **20** (as shown by first printer **22**) with a monitor **14**, first keyboard **16**, and first mouse **18**. In this example, control of the peripheral first printer **22** can be maintained by computer **121** even while monitor **14**, first keyboard **16** and first mouse **18** are controlling computer **122**. This is because switch **10** can switch between a first channel (not shown) connecting monitor **14**, first keyboard **16** and first mouse **18** to first computer **121** and a third channel (not shown) connecting monitor **14**, first keyboard **16** and first mouse **18** to second computer **122**, while maintaining a second channel (not shown) connecting first computer **121** to first printer **22** such that a first data flow between first computer **121** and first printer **22** is not interrupted. Moreover, when one of the first and third communication links is established, the other one of the first and third communication links is disconnected and the second communication link remains connected.

With reference to FIG. **2**, a more robust use is shown permitting a user to control a larger number of computer systems **12** (represented by first computer **121**, second computer **122**, third computer **123**, and fourth computer **124**), and USB compatible peripherals **20** with monitor **14**, first keyboard **16**, and first mouse **18**. Note that it is possible to have one or more than one USB hub **24** also connected to signal switch **10**, which in turn can connect to one or more than one further peripherals such as scanner **241**, or one or more than one downstream hub **242**, which in turn may be connected to one or more than one peripherals such as second printer **2421**. It thus can be seen that any desired tree of hubs/peripherals can be connected to signal switch **10** and thus controlled synchronously or asynchronously by the one or more than one computer systems **12** under the management of a single set of monitor **14**, first keyboard **16**, and first mouse **18**.

Thus, for example, the first data flow between first computer **121** and first printer **22**, a second data flow between first computer **121** and scanner **241**, and a third data flow between first computer **121** and second printer **2421** all could be maintained without interruption while keyboard **16** and mouse **18**, and optionally monitor **14**, are switched among computer systems **12**.

Peripheral devices that can be connected with the signal switch include but are not limited to a USB hub, printer, scanner and camera. Other examples of peripherals will be understood by one skilled in the art with reference to this disclosure.

With reference to FIG. **3**, in a still further use of the signal switch, by way of example it is possible to connect multiple KM (keyboard and mouse) devices such as second keyboard **161**, third keyboard **162**, second mouse **181**, second mouse **182**, first composite KM device **191** and second composite KM device **192**. Preferably, since a signal switch usually only has two USB console ports, one or more than one downstream

hub may be connected, such as first downstream hub **171** and second downstream hub **172**, to which may be connected one or more than one KM devices.

With reference to FIG. **4**, the signal switch **10** comprises a central processing unit ("CPU") **30** for managing the signal switch **10**. A USB hub switch module **32** is connected to the CPU **30** and is configured to communicate with a plurality of computer systems **12** through first output ports **34**. The USB hub switch module **32** is also configured to communicate with peripheral devices **20** through output ports **36**. In FIG. **4**, four connections are shown between first output ports **34** and the USB hub switch module **32**, but this is by way of example only. The number of connections will equal the number of computer systems **12** for which the signal switch **10** is configured.

Likewise, in FIG. **4**, two connections are shown between second output ports **36** and the USB hub switch module **32**, but this is also by way of example only. The number of connections will equal the number of peripheral output ports for which the signal switch **10** is configured.

The USB hub switch module **32** is a bridge between peripheral devices **20** and computer systems **12** and allows the signal switch **10** to connect each of a plurality of computer systems to one or more than one peripheral device. Construction of a circuit suitable as a USB hub switch module is well known in the art with reference to this disclosure. In one preferred embodiment, the USB hub switch module includes 4 USB hubs and matrix analog switches which are controlled by CPU firmware. Texas Instruments® manufactures USB Hub chips that are suitable for this module, and the module can be constructed using Application Specific Integrated Circuit (ASIC) design methodology.

A USB device control module **38** for controlling signals is connected to the CPU **30** and the USB HUB switch module **32**. The USB device control module **38** comprises USB device chips that are used to emulate the console devices, such as first keyboard **16** and first mouse **18**, for the first output ports **34**. In other words, by having a USB device chip emulate console devices attached to a first computer system, actual console devices may be switched to a second or different computer system, leaving any channels between the first computer system and peripherals connected, any data flow in such channels uninterrupted, and the first computer system still processing as if the actual console devices, now emulated, were still connected. These chips are controlled by CPU **30** firmware. One device chip is required for each computer system **12**. Construction of a circuit suitable as a USB device control module is well known in the art with reference to this disclosure.

In addition, the USB device control module **38**, under control of the CPU **30** firmware, may perform additional emulation so that the keyboard and mouse signals from the same user console can be switched to two different computers to control the two different computers. A user console refers to a set of user console devices typically including a monitor, a keyboard and a mouse such as those shown in FIG. **1** (monitor **14**, keyboard **16**, mouse **18**). In a conventional a KVM switch system, the keyboard and mouse of one user console are always switched to the same computer. Using the emulation method described below, the keyboard **16** of the user console can be used to control one computer (for example, the first computer **121** in FIG. **1**) and the mouse **18** of the user console can be used to control another computer (for example, the second computer **122** in FIG. **1**).

Specifically, the user may instruct the signal switch **10** to switch the keyboard **16** and the mouse **18** to control two different computers. In such a situation, each of the two computers has only a keyboard or a mouse actually transmitting data to it, and the USB device chips in the USB device control module **38** emulate the null keyboard or mouse for the respective computers. For example, if the keyboard **16** is switched to the first computer **121** and the mouse **18** is switched to the second computer **122**, the USB device chip for the first computer **121** emulates a null mouse, and the emulated null mouse signals along with the emulated keyboard signals which represent actually transmitted keyboard data from the keyboard **16** are sent to the first computer **121** via the USB hub switch module **32**. In the mean time, the USB device chip for the second computer **122** emulates a null keyboard, and the emulated null keyboard signals along with the emulated mouse signals which represent actually transmitted mouse data from the mouse **18** are sent to the second computer **122** via the USB hub switch module **32**. As a result, to both the first and second computers **121** and **122**, it appears that both a keyboard and a mouse are present. This enables the keyboard and the mouse of one user console to separately control two computers.

When the keyboard **16** and the mouse **18** of the user console are separately controlling two computers, the video signals from the two computers may both be displayed on the monitor **14** using known technologies such as picture-in-picture (PIP) or other desktop sharing techniques. PIP may be implemented in a number of ways, such as by providing a video overlay circuit in the USB hub switch module **32** which is described in more detail later. Alternatively, the monitor may be switched to the same computer as the mouse, or switched to the same computer as the keyboard, as controlled by hot keys or buttons on the signal switch. As another alternative, two monitors may be provided, one being switched together with the mouse and the other being switched together with the keyboard.

In FIG. **4**, four connections are shown between the USB device control module **38** and the USB hub switch module **32**, but this is by way of example only. The number of connections will equal the number of computer systems **12** for which the signal switch **10** is configured. Each of the four connections may be a USB line that transfers both USB keyboard and USB mouse signals, or they may be two PS/2 lines for the keyboard and mouse signals, respectively. In one preferred embodiment, the USB device control module includes 4 USB device chips and the chips are also controlled by CPU firmware. Philips Semiconductors® makes chips suitable for use in this module, and the module may also be constructed using Application Specific Integrated Circuit (ASIC) design methodology.

Referring to FIG. **4**, the CPU **30** comprises a first memory **40** for storing a management program **42** for managing the operation of the signal switch **10**. A flowchart of the function of a portion of management program **42** suitable for use in embodiments of the present invention is illustrated in FIG. **5**, and described below.

A USB host control module **44** is configured to communicate with a plurality of console devices and is connected to the CPU **30**. Construction of a circuit suitable as a USB host control module is well known in the art with reference to this disclosure. The USB host control module **44** itself comprises a root hub **46** for communicating with one or more than one console devices or downstream hubs, through third output ports **48**. The root hub is a USB compatible hub, which is well known in the art with reference to this disclosure.

As shown in FIG. **3**, one or more than one downstream hub may be connected to the signal switch **10**, such as first downstream hub **171** and second downstream hub **172**, communi-

cating with root hub **46** through one of the third output ports **48**. It is possible to daisy chain up to 127 devices by adding more downstream hubs.

Typically, third output ports **48** comprise two physical ports. Optionally, in a different embodiment, an Internal additional console USB hub (not shown) may be connected to the root hub **46** for increasing the number of third output ports **48** available for connecting console devices. The CPU **30** firmware has the ability to handle hub functions. Construction of firmware suitable to run the CPU according to the method disclosed herein is known in the art with reference to this disclosure.

An optional video/panel control device module **50** is connected to the CPU **30** for communicating with a variety of optional panel display devices **54** (shown in broken lines), such as light panels, LEDs, buttons, video controller switches, or other optional panel devices. If an on screen display ("OSD") function is provided, then an optional OSD control device module **56** (shown in broken lines) is connected to the CPU **30** and the video/panel control device module **50** for controlling and adjusting signals to an external monitor **14** through fourth output port **52**. The video signals from a selected computer are outputted by the USB hub switch module **32** and applied to the video/panel control device module **50** (if it is present) or to the fourth output port **52**. Construction of circuits suitable for use as a video/panel control device module or optional OSD control device module is known in the art with reference to this disclosure.

The structure of the USB hub switch module **32** and its connection to various other components are illustrated in more detail in FIG. **6**. As shown in FIG. **6**, the hub switch module **32** includes a plurality of USB hubs **61**, here show as four USB hubs **61-1** to **61-4**. Each hub **61** is connected to a computer **12**, here shown as computers **121** to **124**. The first output ports **34** disposed between the USB hub switch module **32** and the computers **12** in FIG. **4** is not shown in FIG. **6**. Each USB hub **61** is also connected the USB device control module **38** (corresponding to the four lines between the components **32** and **38** shown in FIG. **4**).

Each hub **61** is connected to an analog switch **62**, which selectively connects one of the hubs **61** to another USB hub **64**. The hub **64** is for connecting to a plurality of peripheral devices, shown here as peripheral devices **22-1** and **22-2**. The second output port **36** disposed between the hub **64** and the peripheral devices **22** (see FIG. **4**) is not shown in FIG. **6**. The hub **64** is optional; if it is not present, the analog switch **62** connects one of the hubs **61** directly to a peripheral device **22**.

The USB hub switch module **32** also includes a video switch **63** connected to the video signal port of each of the computers **121** to **124**. The video switch **63** selectively outputs the video signals from one of the computers. In addition, the video switch **63** may include a video overlay circuit or other implementations to generate PIP video signals using video signals from two computers. PIP technologies are generally known in the art and a more detailed description is omitted here. The output video signal is applied to either the video/panel control device module **50** or the fourth output port **52** as described earlier. The CPU **30** is connected to and controls the analog switch **62** and the video switch **63**.

With reference to FIG. **5**, the process of a portion of a management program **42** suitable for use in embodiments of the present invention may proceed as follows. In step **210** the signal switch **10** is initialized. In step **212**, a root hub **46** is enumerated and any root hub message from the root hub **46** is saved. In step **214** it is determined whether any device is connected to the root hub **46**. If a device is determined to be connected to the root hub **46**, program process passes to step **216**, else the process passes to step **226**.

In step **216**, each device determined to be connected to the root hub **46** is enumerated, and a device message from the USB device determined to be connected to the root hub **46** is parsed and saved in a suitable memory.

Next, in step **218**, it is determined whether any downstream hub is connected to the root hub **46**. If no downstream hub is determined to be connected to the root hub **46**, the process proceeds to step **228**. If a downstream hub is detected, the process passes to step **220**. In step **220** each downstream hub determined to be connected to the root hub **46** is enumerated and a downstream port status of the hub is received. The process then proceeds to step **222**.

In step **222**, it is determined whether any device is existing in a port of the downstream hub. If no device is determined to be existing in a port of the downstream hub, the process proceeds to step **228**. If, in step **222**, a device is determined to be existing in a port of a downstream hub, the process proceeds to step **224** where each such device is enumerated and a connecting device message is parsed and saved in a suitable memory. The process then proceeds to step **228**.

In step **228**, it is determined whether the connected device is a HID keyboard or mouse or other HID compliant device. As will be evident to those skilled in the art with reference to this disclosure, this step could test for compliance with any desired industry standard or device class. If the connected device is not such a device, the process proceeds to step **232** which is an error process which results in resetting a HOST control RAM in step **240**. If the connected device is determined to be complaint, then in the next step **230**, each such connected device is enumerated and its report data is parsed. The reason for the compliance test is that the switch has been constructed to emulate certain console devices which comply with an industry standard device class.

Control then passes to step **226** where the HUB switch module **32** is polled. In optional step **234** any panel or LED circuit is polled. In step **238** it is determined whether any downstream port is unplugged or plugged. If the downstream port is unplugged or plugged the process proceeds to step **240** where the HOST control RAM is reset. After resetting the HOST control RAM in step **240** the process returns to step **212**. Else, the process proceeds to step **242** where the KVM devices are polled and the process returns to step **234**.

FIG. **7** illustrates a signal switch **710** according to another embodiment of the present invention, which is used in combination with a plurality of computer connection modules **72** (only one is shown) and one or more console connection module **74** (only one is shown). Each computer is connected to the signal switch **710** via one computer connection module **72**. Each user console is connected to the signal switch **710** via one console connection module **74**, which can also connect one or more peripheral devices to the signal switch **710**. In FIG. **7**, some components are the same as or similar to the corresponding components in FIG. **4**, and similar reference numbers as in FIG. **4** are used for such components. In particular, the structures and functions of the USB hub switch module **732**, the USB device control module **738**, the CPU **730**, the optional video/panel control device module **750**, the optional panel display devices **754**, the optional OSD control device module **756**, and the USB host control module **744** are the same or similar to the corresponding components **32**, **38**, **30**, **50**, **54**, **56** and **44** of the signal switch **10** shown in FIG. **4**.

In the signal switch **710** of FIG. **7**, the second output ports **36** in the embodiment of FIG. **4** is not present; rather, the data signals for the peripheral devices **20** outputted by the USB

hub switch module **732** are inputted to a digital signal decoder/encoder **764** as described later.

The computer connection module **72** is a device that connects to first ports **734** of the signal switch **710** by a long distance cable such as a Category 5 (Cat 5) cable, and connects to a computer system **12** by a number of short (typically built-in) cables such as USB cable, PS/2 cables, VGA cable, etc. (not shown in FIG. **7**). In one embodiment, the computer connection module includes a body and three cables connected to the body, wherein each of the three cables includes a plug, the plugs being a VGA interface, a PS/2 interface, and a PS/2 interface, respectively, for connecting to the computer. In another embodiment, the computer connection module includes a body and two cables connected to the body, wherein each of the two cables includes a plug, the plugs being a VGA interface and a USB interface, respectively, for connecting to the computer. Only one first port **734** is shown in FIG. **7** to avoid overcrowding, but it should be understood that there are multiple first ports **734** for connecting to multiple computers. The signal switch **710** includes an analog signal decoder **758**, connected to the first ports **734**, which decodes the video signals received from the computer **12** via the computer connection module **72** and transmits the video signals to the USB hub switch module **32**. The signal switch **710** also includes a digital signal decoder/encoder **760**, connected to the first ports **734**, which encodes the keyboard and mouse signals received from the USB hub switch module **732** and transmits the keyboard and mouse signals to the computers **12** via the computer connection module **72**, and decodes data signals (e.g. data intended for a peripheral device) received from the computer **12** via the computer connection module **72** and transmits them to the USB hub switch module **732**. Different pairs of wires within the Cat 5 cable are used to carry the video signals and the keyboard, mouse and data signals between the signal switch **710** and the computer connector module **72**. For example, three of the four pairs of wires may be used to carry the RGB video signals and the fourth pair of wires may be used to carry the keyboard, mouse, and data signals.

The console connection module **74** is a device that connects to second ports **766** of the signal switch **710** by a long distance cable such as a Cat 5 cable, and connects to the console devices such as a keyboard **16**, a mouse **18** and a monitor **14**, as well as peripheral devices **20**, by a number of short (typically built-in) cables such as USB cable, PS/2 cables, VGA cable, etc. (not shown in FIG. **7**). Compare to the signal switch **10** of FIG. **4**, the second ports **766** replaces the output ports **48** and **52** in FIG. **4**. Only one second port **766** is shown in FIG. **7** to avoid overcrowding, but it should be understood that there may be multiple second ports **766** for connecting to multiple user consoles. The signal switch **710** includes an analog signal encoder **762**, connected to the second ports **766**, which encodes the video signals received from the video control device module **750** and transmits the video signals to the monitor **14** via the console connection module **74**. The signal switch **710** also includes a digital signal encoder/decoder **764**, connected to the second ports **766**, which decodes the keyboard and mouse signals received from the console devices (keyboard **16** and mouse **18**) via the console connection module **74** and transmits them to the USB host control module **744**. The digital signal encoder/decoder **764** also encodes the data signals received from the USB hub switch module **732** and transmit them to the peripheral devices **20** via the console connection module **74**, or, receives the data signals from the peripheral devices **20** via the console connection module **74** and decodes them then transmits them to the USB hub switch module **732**. Different pairs of wires within the Cat 5 cable are used to carry the video signals and the keyboard, mouse and data signals between the signal switch **710** and the console connector module **74**. For example, three of the four pairs of wires may be used to carry the RGB video signals and the fourth pair of wires may be used to carry the keyboard, mouse, and data signals.

In both the signals switches of FIGS. **4** and **7**, the firmware controls the USB console devices and PC console device emulations. It is not necessary to control the USB peripherals, since the signal switch generates a path or channel between the USB peripherals and the linked PCs which is undisturbed by switching the channels between the complaint KM devices and the PCs.

Those skilled in the art with reference to this disclosure will be able to construct a USB emulation program suitable for use in embodiments of the present invention by following the human interface device (HID) specification. The HID specification defines a quasi-language for the HID-compliant USB device to tell the host how to interpret the data that the host receives. This quasi-language is flexible and permits many ways to describe the same piece of functionality. The signal switch will be useable with other industry standard specifications that define a procedure to tell a host how to interpret the data that the host receives from a standards-compliant device.

Currently, a Device Class Definition for Human Interface Devices (HID) Firmware Specification—Jun. 27, 2001, Version 1.11, is available at http://www.usb.org/developers/data/devclass/HID1.sub.--11.pdf and is incorporated herein. The most current version of the specification and other HID related information is maintained at http://www.usb.org/developers/hidpage.html.

Using a bus analyzer, such as one available currently from Computer Access Technology Corp. it is possible to read the USB bus and analyze the data packets coming from a keyboard and a mouse. The HID specification provides interpretation of the packet meaning. By providing that all the console devices be complaint with the HID specification, or some future standard specification, it is only necessary to emulate such HID or standards-compliant devices.

In a preferred embodiment the whole system programs, which include USB Hub switch control, USB device chip control (device emulation) and console device emulation (Host emulation) are all built in a CPU chip (Flash ROM or PROM). One skilled art with reference to this disclosure and following the referenced specifications will be able to write a USB emulation program suitable to make a switch appear as a PC to peripheral devices, and enable the switch to communicate with USB devices or USB PCs at the same time.

The term "channel", as used in the phrase "KVM channels" and "peripheral channels", refers to the hardware structure and logic path for data and electrical signals. Any suitable hardware structure or combination thereof can be used to implement a channel, such as communication lines, encoders/decoders, crosspoint switches, device controllers, ASICs, FPGAs, etc. Another term that can be used to refer to the same concept is "communication link".

In the foregoing specification, the invention has been described with reference to specific embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense. It should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the below claims.

What is claimed is:

1. A keyboard-video-mouse (KVM) switch, comprising:
a first computer port for connecting to a first computer;
a second computer port for connecting to a second computer;
a peripheral port for connecting to at least one peripheral device;
a console port for connecting to a plurality of user console devices;
a first communication link connecting the first computer port and the console port;
a second communication link connecting the first computer port and the peripheral port;
a third communication link connecting the second computer port and the console port; and
a switching unit connected to the first computer port, the second computer port, the peripheral port and the console port for switching between the first and third communication links without interrupting the second communication link.

2. The KVM switch of claim 1, wherein when one of the first and third communication links is established, the other one of the first and third communication links is disconnected and the second communication link remains connected.

3. The KVM switch of claim 1, wherein the peripheral port is a USB interface.

4. A keyboard-video-mouse (KVM) switch system, comprising:
a first computer connection module for connecting to a first computer;
a second computer connection module for connecting to a second computer;
a console connection module, the console connection module including at least one console connector for connecting to at least one user console device and at least one peripheral connector for connecting to at least one peripheral device;
a first communication link connecting the first computer connection module and the console connector of the console connection module;
a second communication link connecting the first computer connection module and the peripheral connector of the console connection module;
a third communication link connecting the second computer connection module and the console connector of the console connection module; and
a switching module connected to the first computer connection module, the second computer connection module and the console connection module for switching between the first and third communication links without interrupting the second communication link.

5. The KVM switch system of claim 4, wherein each of the first computer connection module and the second computer connection module includes a body and three cables connected to the body.

6. The KVM switch system of claim 4, wherein the switching module connects to each of the first computer connection module, the second computer connection module, and the console connection module via a Category 5 cable.

7. The KVM switch system of claim 4, wherein each of the first computer connection module and the second computer connection module includes a body and two cables connected to the body.

8. The KVM switch system of claim 4, wherein the switching module comprises:
a CPU comprising a first memory for storing a management program for managing the switching module;
a hub switch module connected to the CPU and configured to communicate with the first computer and second computer, and the user peripheral device, such that a signal transmitted from the hub switch module to the peripheral device emulates signals originating from one of the computers;
a device control module connected to the CPU and the hub switch module for emulating the user console device according to a standard;
a host control module connected to the CPU and configured to communicate with the user console device; and
a video control device module connected to the CPU and configured to communicate with a video monitor device.

9. The KVM switch system of claim 4, wherein the peripheral connector is a USB interface.

10. The KVM switch system of claim 5, wherein each of the three cables includes a plug, the plugs being a VGA interface, a PS/2 interface, and a PS/2 interface, respectively, for connecting to the first or second computer.

11. The KVM switch system of claim 8, wherein each of the two cables includes a plug, the plugs being a VGA interface and a USB interface, respectively, for connecting to the first or second computer.

12. The KVM switch system of claim 8, wherein the switching module further comprises analog signal decoders, which decode the video signals received from the first computer and the second computer via the first computer connection module and second computer connection module and transmit the decoded video signals to the USB hub switch module.

13. The KVM switch system of claim 8, wherein the switching module further comprises digital signal decoders/encoders, which encode keyboard and mouse signals received from the USB hub switch module and transmit the keyboard and mouse signals to the first computer and second computer via the first computer connection module and second computer connection module, and decode data signals received from the first computer and second computer via the first computer connection module and second computer connection module and transmit them to the USB hub switch module.

14. The KVM switch system of claim 8, wherein the switching module further comprises an analog signal encoder, which encodes the video signals received from the video control device module and transmits the video signals to a monitor via the console connection module.

15. The KVM switch system of claim 8, wherein the switching module further comprises a digital signal encoder/decoder, which decodes keyboard and mouse signals received from the user console device via the console connection module and transmits them to the USB host control module, wherein the digital signal encoder/decoder encodes the data signals received from the USB hub switch module and transmits them to the peripheral devices via the console connection module, and wherein the digital signal encoder/decoder receives data signals from the peripheral devices via the console connection module and decodes them then transmits them to the USB hub switch module.

16. A signal switch for sharing a set of console devices and one or more peripheral devices among any of a plurality of computer systems, comprising:
a first channel for connecting the set of console devices comprising a first console device and a second console device to a first computer system selected from the plurality of computer systems;

a second channel for connecting the first selected computer system to a peripheral device selected from the one or more peripheral devices;

a third channel for connecting the first console device to the first selected computer system;

a fourth channel for connecting the second console device to a second selected computer system; and

a switching module for switching the set of console devices from the first channel to the third channel and the fourth channel without changing the second channel between the first selected computer system and the selected peripheral device.

17. The signal switch of claim **16**, wherein one of the first and second console devices is a keyboard and the other one of the first and second console devices is a mouse.

18. The signal switch of claim **16**, wherein the set of console devices further comprise a third console device.

19. The signal switch of claim **16**, wherein the switching module switches the set of console devices from the third and fourth channels to first channel without changing the second channel between the first selected computer system and the selected peripheral device.

20. The signal switch of claim **16**, wherein the second channel is a USB interface.

21. The signal switch of claim **18**, wherein the third console device is a monitor.

22. The signal switch of claim **18**, wherein the third channel allows the first console device and the third console device to connect to the first selected computer system.

23. The signal switch of claim **18**, wherein the fourth channel allows the second console device and the third console device to connect to the second selected computer system.

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